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Development Of Problem-Based Learning Geography Teaching Modules To Improve Critical Thinking Skills In Biodiversity Materials Class XI

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Abstract

This study developed a Problem-Based Learning (PBL)–based Geography teaching module on Biodiversity for Grade XI students at SMA Negeri 2 Wonosari. The module was created to provide learning materials that encourage active participation and strengthen students' critical thinking and problem-solving skills in addressing environmental issues. The research employed a Research and Development (R&D) approach using the 4-D model, consisting of Define, Design, Develop, and Disseminate stages. Validation results from module and material experts indicate that the teaching module is highly feasible for use, with a validity score of 87% from the module expert and 90% from the material expert, both falling into the "very good" category with minor revisions. Limited trials conducted with students produced scores ranging from 70% to 87%, placing the module in the "good" to "very good" category. The results also show that the PBL-based Geography module is effective in improving students' critical thinking skills, with an average N-gain of 0.47 categorized as moderate. Significant improvement was observed particularly in students' ability to provide simple explanations and draw conclusions related to biodiversity and its connection to environmental sustainability. Thus, the PBL-based Geography teaching module can make a positive contribution and serve as an alternative learning resource that supports the implementation of the Kurikulum Merdeka, particularly in enhancing quality learning and strengthening the Pancasila Student Profile through contextual and participatory learning

Keywords: Teaching Module, Geography, Problem-Based Learning, Biodiversity, Kurikulum Merdeka

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INTRODUCTION

Education in Indonesia continues to advance in response to the demands of an increasingly complex and dynamic global landscape. One of the central goals of national education is to prepare a generation that not only masters knowledge, but is also equipped with strong critical thinking skills to address various real-world problems. These competencies are crucial as students face global challenges, particularly escalating environmental issues that require analytical, evaluative, and solution-oriented thinking (Widodo, 2021).

Within the framework of the Independent Curriculum (Kurikulum Merdeka), the strengthening of student competencies is emphasized through contextual, collaborative, and student-centered learning approaches. The Minimum Competency Assessment (AKM) supports this goal by measuring students' abilities in reading literacy and numeracy through problem-based tasks that assess understanding, analysis, and evaluation rather than rote memorization. At the same time, the Minimum Mastery Criteria (KKM) remains a benchmark for determining students' attainment of learning objectives, making the integration of AKM and KKM essential for effective and meaningful instruction (Rohmatulloh et al., 2023).

In Geography education, Biodiversity is a crucial topic that contributes significantly to developing students' environmental awareness and sense of responsibility toward the sustainability of natural resources. This content not only introduces students to the diversity of flora and fauna but also guides them to understand the causes of biodiversity, the consequences of environmental degradation, and the importance of conservation efforts. Strengthening students' understanding of these concepts requires a learning approach that promotes critical, analytical, and contextual thinking. As Geography learning at the Grade XI level aims to build students' spatial understanding, environmental awareness, and regional perspectives, learning materials must be aligned with students' developmental stages and cognitive readiness (Wijaya, 2020). Topics related to the geosphere atmosphere, lithosphere, hydrosphere, and biosphere must therefore be delivered through approaches that facilitate higher-order thinking and meaningful engagement. Despite its relevance, many students still lack a strong grasp of biodiversity issues, including the impacts of biodiversity loss and strategies for addressing these challenges. This gap indicates the need for more effective instructional media that can deepen conceptual understanding while enhancing critical thinking abilities (Zubaidah, 2020).

Problem-Based Learning (PBL) offers a promising solution, as it provides students with opportunities to investigate real environmental problems, such as deforestation, illegal hunting, and climate change, while developing critical, analytical, and creative thinking skills. Through collaboration and guided inquiry, PBL encourages students to construct solutions based on

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evidence and contextual analysis. However, successful implementation of PBL requires structured and well-designed instructional materials. A PBL-based teaching module for Biodiversity can serve as a comprehensive learning tool that supports interactive, engaging, and meaningful learning aligned with students' characteristics and the demands of the curriculum (Hidayati, 2021).

Based on these considerations, this study was conducted to develop a Problem-Based Learning (PBL) Geography teaching module for Biodiversity material in Grade XI**,** with the aim of improving students' critical thinking skills and deepening their understanding of biodiversity conservation through contextual and problem-oriented learning experiences.

METHOD

This study employed the *Research and Development (R&D)* method, which, as noted by Sugiyono (2019), constitutes a scientific approach used to investigate, design, produce, and validate educational products. In line with this view, Maydiantoro (2021) asserts that R&D is a research method specifically utilized to develop and evaluate instructional products so that they may be effectively implemented in educational settings. The development model adopted in this study was the Four-D (4D) Model**,** introduced by Thiagarajan (1974), which consists of four stages: Define, Design, Develop, and Disseminate**.**

The scope of this research was limited to the Develop stage, focusing on the creation and refinement of a Problem-Based Learning (PBL)–based Geography teaching module on Biodiversity for Grade XI students. The resulting product underwent a limited trial to obtain data regarding its validity, practicality, and initial effectiveness in enhancing students' critical thinking skills.

The research subjects comprised Grade XI students from the school in which the study was conducted, as well as a Geography teacher who evaluated the feasibility of the module. Data collection techniques included the use of expert validation sheets**,** student response questionnaires**,** teacher response questionnaires**,** student activity observation sheets**,** and a critical thinking skills test.

The module's validity was assessed by two media validators and one subject matter expert**,** who evaluated several aspects of feasibility, including content accuracy, alignment with PBL syntax, clarity of instructional procedures, completeness of module components, linguistic appropriateness, and visual quality. Validity analysis was conducted by calculating the percentage scores and categorizing them based on predetermined validation criteria.

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RESULTS AND DISCUSSION

Define Stage

The results of each activity at this defining stage can be described as follows:

a. Final Preliminary Analysis Results

This early-recent analysis is the process of identifying the problems faced when carrying out the learning process. This analysis is carried out through direct observation. The results of the observation show that there are still several problems faced in the teaching and learning process. These problems are that there is no teaching module that is used as a learning support, where the teaching modules used are still sourced from publishers and not the result of teacher development. The learning process that is still fixated on the teacher, the lack of understanding of students for every step of work carried out in the discussion which can be seen in the learning process in the classroom shows that students still have difficulty solving problems or solving problems related to geography materials. This reduces students' critical thinking skills in working on and solving problems or problems in geography books (Selviani, 2019).

b. Results of Teaching Module Analysis

From the results of the analysis of the teaching module, the details of the learning objectives can be compiled as follows:

1. Geography 1 teaching module on flora and fauna diversity and factors that influence it
2. Geography 2 teaching module on the distribution of flora and fauna in Indonesia and the World
3. Geography 3 teaching module on the conservation and utilization of Indonesia's flora and fauna as natural resources (Indrasari et al., 2023)

In the development of this teaching module, the focus is on biodiversity materials that are directly related to the students' environment. Their knowledge will also be formed depending on how far they interact with their environment. According to Nuryani (2020), things that need to be considered to know the characteristics of students include: individual academic ability, physical characteristics, group work ability, learning motivation, economic and social background, previous learning experience and so on (Ashari & Salwah, 2017).

Design stage

At this planning stage, the initial draft of the geography teaching module includes:

c. Design Stage

The design stage is prepared based on the analysis of needs, curriculum, materials, and the objectives of the preparation of teaching modules. Then this is outlined in the creation of

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teaching materials and question grids that will be used as a reference in making an initial draft of the geography-based teaching module *Problem Based Learning* (Amaliyah et al., 2023).

d. Stages of Drafting Teaching Modules

The parts of the geography teaching module are as follows:

1) General information containing the name of the educational unit, subject, compiler, class/phase, element/topic, time allocation, Pancasila student profile, infrastructure, achievement targets, learning models, learning methods, and the school year.

2) The initial competency contains the learning outcomes of phase F and learning objectives.

3) Core competencies contain (1) the learning stage; (2) teacher activities and (3) time allocation. At the stage of activities, teachers and students are divided into:

1. Preliminary activities consist of preparation, perception and motivation stages.
2. Core activities include:

a) Phase 1: Orientation of students to problems

b) Phase 2: Organizing Students

c) Phase 3: guide individual and group investigations

d) Phase 4: develop and present the work

e) Phase 5: analyze and evaluate the problem-solving process.

3. The closing activity is evaluation and follow-up plan.

4) Assessment; The type of assessment consists of initial assessment (before learning), formative assessment (during learning), summative assessment (end of learning) with the form of assessment written (Fazriah et al., 2024).

5) Remedial and enrichment are:

a) Remedial is given to students who do not understand the concepts that have been learned. Remedial is carried out by:

1) Relearning

2) Specific guidance

3) Specific assignments of training

4) The Importance of Peer Tutoring

b) Enrichment is given to students who already understand the concepts that have been learned and 632ias continues the next learning. Enrichment is carried out by group learning and independent learning (Santoso & Suasti, 2024).

6) Reflection is divided into:

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a) reflection of the teacher; It is carried out as a reflection material by a teacher on the learning practices that he has implemented. The purpose of this reflection is to understand what works, what is less effective, and how ordinary improvements can be made to make classroom learning better.
b) Student reflection is a conscious and critical thinking process carried out by students to evaluate their own learning experiences. The goal is for students to understand what they have learned, how they learned, and what they have learned. 633IAS they do to improve the learning process in the future (Islami & Hadi Soekamto, 2022).

7) The appendix consists of appendices of student worksheets, and a glossary in the form of a list of special terms or important words along with their definitions or explanations used in the sjsr module and textbooks used.

8) Bibliography: which contains a list of sources or references used in learning. These sources 633are in the form of books, journals, articles, websites, or other documents that are used as references.

The details of the stages of the activity above, aim to build students' critical thinking skills by using the geography teaching module (Mazlin et al., 2023).

Development Stage

At the stage *develop* or this development aims to produce valid, practical and effective teaching modules in learning activities. In this teaching module development stage, development activities are carried out with the following steps: a) module validation by experts/experts, draft 1 learning module design is given to experts/experts for assessment, assessment by experts is carried out by filling out the teaching module validation assessment sheet in the form of a sheet *chek list* covers several different aspects for each expert. Furthermore, the module has been revised by taking into account the suggestions or inputs from the expert/expert; b) revision of the teaching module in accordance with the input from experts or experts at the time of validation; c) limited trials in classroom learning (Elita et al., 2025).

The results of the validation of the geography teaching module in this development research are in the form of suggestions or inputs for the revision of the teaching module and assessment scores from experts, including the following:

a. Data Analysis of the Validity of Geography Teaching Module

1) Validation Results of Geography Teaching Module by Validator 1

The results of the validation assessment of the geography teaching module were carried out by the geography lecturer as validator 1 , namely Mrs. Rusiyah S.Pd, M.Sc and validator 2 was

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Mr. M. Iqbal Liayong, S.Pd., M.Pd. The assessment criteria for the geography teaching module amounted to 20 criteria, including 5 aspects of assessment, namely module components, module presentation, appearance, language, and means of critical thinking. The validator assessment of the Problem-Based Learning-based geography teaching module to improve students' critical thinking skills on biodiversity in the even semester is as follows:

Table ! Results of Validation of Geography Teaching Module by Validator 1

Assessment Aspects	Criteria Number	Shoes	Score Per Aspect	Average	Presentase
Components Module	1	4	4	4	100%
Presentation of Modules	2	4	21	3,5	87,50%
	3	3			
	4	3			
	5	4			
	6	4			
	7	3			
Display	8	4	13	3,25	81,25%
	9	3			
	10	3			
	11	3			
Language	12	3	14	3,5	87,50%
	13	4			
	14	4			
	15	3			
A Means of Critical Thinking	16	3	18	3,6	90%
	17	4			
	18	4			
	19	3			
	20	4			
Sum		**70**	**70**	**3,57**	
Average Criteria (%)		**87,50%**			

The assessment consisted of 4 categories, namely a score of 4 with a very good category, a score of 3 with a good category, a score of 2 with a fairly good category and a score of one with

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a poor category. Based on the assessment of the component aspects of the module, the geography teaching module received an average score of 4 with a percentage of 100% with the category of very good (SB), Module presentation get a score of 3.5 with a percentage 87,50% Excellent category (SB), aspects Display get a score of 3.25 with a percentage 81,25% Excellent category (SB), Language aspects get a score of 3.5 (Indriani et al., 2023)

By a percentage 87,50% Excellent category (SB), and a means of critical thinking Getting Points 3,6 by a percentage 90% category of excellent (SB). Based on the results of the calculation, the geography teaching module that has been developed according to validator 1 is categorized as very good (SB), thus the geography teaching module meets the validity requirements (Kusumaningtyas et al., 2023).

2) Results of Validation of Geography Teaching Module by Validator 2

The results of the validation assessment of the geography teaching module carried out by the geography lecturer as validator 2, namely Mr. M. Iqbal Liayong, S.Pd., M.Pd. The validator assessment of the geography teaching module based *on Problem Based Learning* to improve students' critical thinking skills on biodiversity in the even semester, are as follows:

Table 2 Validation Results of Geography Teaching Module by Validator 2

Assessment Aspects	Criteria Number	Shoes	Score Per Aspect	Average	Presentase
Components Module	1	4	4	4	100%
Presentation of Modules	2	4	21	3,5	87,50%
	3	3			
	4	3			
	5	4			
	6	4			
	7	3			
Display	8	4	13	3,25	81,25%
	9	3			
	10	3			
	11	3			
Language	12	4	15	3,75	93,75%
	13	4			
	14	4			
	15	3			

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A Means of Critical Thinking	16	4	19	3,8	95%
	17	4			
	18	4			
	19	3			
	20	4			
Sum		**72**	**72**	**3,66**	
Average Criteria (%)		**90%**			

The assessment consisted of 4 categories, namely a score of 4 with a very good category, a score of 3 with a good category, a score of 2 with a fairly good category and a score of one with a poor category. The assessment of validator 1 is based on 5 aspects of the assessment, namely module components, module presentation, display, language, and means of critical thinking. Based on the assessment of the component aspects of the module, the geography teaching module received an average score of 4 with a percentage of 100% with the category of very good (SB), Module presentation get a score of 3.5 with a percentage 87,50% Excellent category (SB), aspects Display get a score of 3.25 with a percentage 81,25% Excellent category (SB), Language aspects got a score of 3.75 with a percentage 93,75% Excellent category (SB), and a means of critical thinking Getting Points 3,8 by a percentage 95% category of excellent (SB). Based on the results of the calculation, the geography teaching module that has been developed according to validator 2 is categorized as very good (SB), thus the geography teaching module meets the validity requirements (Prasetya et al., 2022). During the validation process activities carried out by experts, there are several improvements to the teaching modules that have been carried out can be seen in the following table:

Table 3 Results of Module Revisions Based on Expert Input

No.	Suggestions / Comments	Repair
1.	Improve writing that is not in accordance with standard Indonesian.	Re-read and correct words that are not standard according to the Indonesian dictionary.
2.	The use of images needs to be clarified again and based on geographical materials of biodiversity such as animals endemic to the local area	Include images based on biodiversity geography material, namely animals endemic to the local area
3.	Improving critical thinking problems	Questions are made based on facts in

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		daily life by linking critical thinking indicators

Trial Results of Geography Teaching Module

Geography-based teaching modules *Problem Based Learning* which has been revised based on the results of expert validation, will then be tested. This trial was carried out at SMA Negeri 2 Wonosari on 25 students in class XI and was carried out for 3 meetings from December 2 to December 16, 2024. The trial in the classroom is carried out by first giving questions *Pretest* to find out the description of students' initial abilities in biodiversity materials and their application in daily life. Before learning using the geography teaching module that has been developed, after that questions are given *posttest* to find out the final ability of students (Home et al., 2023).

The trial process is a learning process that is carried out in the classroom using the developed teaching modules. Teachers as facilitators in classroom learning. Each meeting is observed in the form of observation of student activities in learning using modules until completion. Students and teachers will be given a questionnaire in response to the geography teaching module. This is intended to see if the geography teaching module developed by the researcher can be used to activate students in learning and can be well received in learning.

Data Analysis of the Practicality of Geography Teaching Module

The practicality of using the geography teaching module was carried out through a limited trial of 25 students in class XI consisting of 11 males and 14 females. In this trial, the researcher used an instrument sheet of observation sheets for student activities, which was given from the beginning to the end of the learning was carried out. This trial was carried out in 3 meetings, assisted by 2 teachers who became observer teams in the classroom. This was carried out to see the practicality of the teaching modules developed by the researcher (Bantenya et al., 2024).

Observation of Students' Activities using the Geography Teaching Module

The data obtained by students through observation sheets by the observer team that have been analyzed and obtained the results of the percentages and qualifications can be seen in the following table 4.8:

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Table 5 Percentage of Observation Results of Students' Activities Using Geography Teaching Module Based on *Problem Based Learning* (Observer 1)

Activities	Meeting			Average Presentase
	1	2	3	
Problem Orientation/Identification	72	74	80	75
Information Collection	72	73	77	74
Analysis and Synthesis	70	73	78	74
Communication and Collaboration	70	72	78	73
Evaluation and Reflection	72	74	77	74

Table 6 Percentage of Observation Results of Students' Activities Using Geography Teaching Module Based on *Problem Based Learning* (Observer 2)

Activities	Meeting			Average Presentase
	1	2	3	
Problem Orientation/Identification	72	75	80	76
Information Collection	71	73	76	73
Analysis and Synthesis	71	73	74	73
Communication and Collaboration	71	74	75	73
Evaluation and Reflection	72	73	76	74

Table 7 Percentage of Observation Results of Student Activities Using Geography Teaching Module Based on *Problem Based Learning* (Observers 1 and 2)

Activities	Meeting		Average Presentase
	1	2	
Problem Orientation/Identification	75	76	75,5
Information Collection	74	73	73,5
Analysis and Synthesis	74	73	73,5
Communication and Collaboration	73	73	73
Evaluation and Reflection	74	74	74

Based on the data from the analysis of student activity observation in the geography teaching module trial, it was obtained that the student activity reached percentage

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completeness (attached). The assessment is based on 5 aspects of student activities, namely orientation/problem identification; information collection; analysis and synthesis; communication and collaboration; evaluation and reflection. Based on the assessment, the five aspects of observer 1 are 75%, 74%, 74%, 74%, 73%, and 74%. Meanwhile, the assessment from observer 2 was 76%, 73%, 73%, 73%, and 74% respectively. Overall, observer 1 and observer 2 for three meetings, at the orientation/problem identification stage, obtained an average percentage of 75.5%; the information collection stage gets an average percentage of 73.5%; the analysis and synthesis stage obtained an average percentage of 73.5%; communication and collaboration received an average percentage of 73%; evaluation and reflection got an average percentage of 74%. This shows that students are active in learning by using geography-based teaching modules *Problem Based Learning* and meet the practicality requirements (Hauko et al., 2025).

Students' Responses to Geography Teaching Modules based on *Problem Based Learning*

The following is a comparison chart of the results of the percentage of student responses to *the Problem Based Learning* teaching module as a whole.

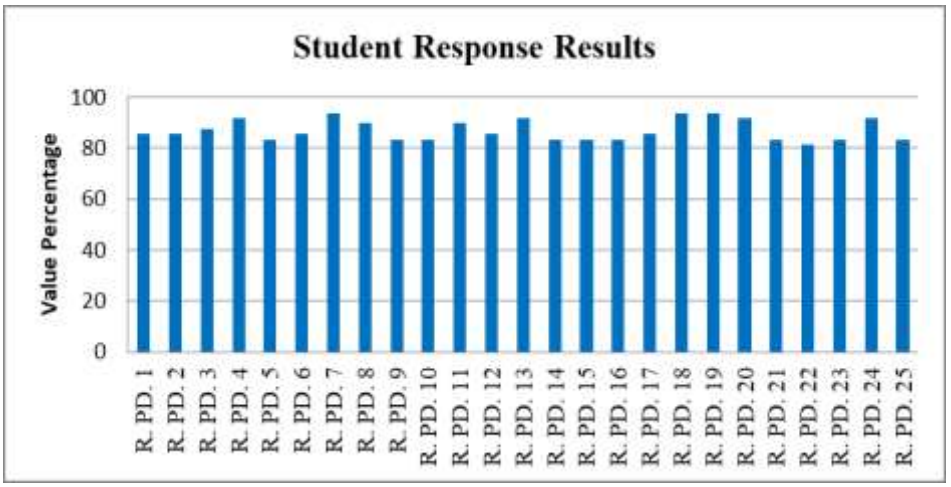


Figure 1 Comparison chart of student response percentage results to Problem Based Learning *Teaching Modules*

Based on the data from the percentage of student responses as many as 25 respondents in the trial of the Problem-Based Learning-based geography teaching module *, a* maximum score was obtained from students. The assessment is based on 4 aspects, namely 1) the suitability of the module with the independent curriculum obtained an average score percentage of 86%, 2)

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the quality of the material through the teaching module obtained an average score percentage of 86%, 3) the impact on learning motivation obtained an average score percentage of 87%, 4) general impressions and suggestions for the geography teaching module obtained an average score percentage of 89%.

Data Analysis of the Effectiveness of Geography Teaching Module

The field implementation test or trial was carried out at SMA Negeri 2 Wonosari in class XI which amounted to 25 people. The critical thinking ability of students at the beginning of learning can be seen from the results *pretest*. Students' critical thinking skills after learning are seen from the results *posttest*. As for the question *pretest* and *posttest* are given in the form of description questions that are made and assessed based on indicators of critical thinking ability, namely providing simple explanations (MPS), building basic skills (MKD), summarizing (MYN), providing further explanations (MPL), and developing strategies and tactics (MST) (Astuti et al., 2023).

The data on the results of students' critical thinking skills showed an increase as seen from the average *pretest* and *posttest scores* measured based on the scoring guidelines for students' critical thinking skills. The results of *the pretest* and *post-test* of students' critical thinking skills can be seen in table 8 below.

Table 8 Pretest and Posttest Results of Critical Thinking Skills

No.	Component	Pretest					Postest				
		MPS	MKD	KID	MPL	MST	MPS	MKD	KID	MPL	MST
1	Number of Learners	25									
2	Average Score	11,72	16,52	6,52	11,36	11,6	18,88	19,04	12,08	14,12	15,04
3	Highest Score	13	20	10	13	16	20	20	15	16	16
4	Lowest Score	6	8	3	8	8	18	16	10	8	8

Based on table 8 above, the results of students' critical thinking skills show an increase in the average *pretest* score and the average *posttest* score. The test of the average improvement

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of critical thinking skills was used to find out how much the students' critical thinking skills improved After learning was carried out using the geography teaching module. The increase in test results given was analyzed using the normalized N-gain formula, the results of which are presented in the following table 9.

Table 9. N-gain Test Results of *Pretest* and *Postest Score Data*

No.	Component	Average Score		Value N-gain	Criterion
		Pretest	*Posttest*		
1	Provide a simple explanation	10,92	18,08	0,80	Tall
2	Build basic skills	15,52	18,04	0,29	Low
3	Conclude	5,92	11,48	0,59	Keep
4	Provide further explanation	10,56	13,32	0,31	Keep
5	Develop strategies and tactics	10,8	14,24	0,38	Keep
Total Values		53,72	75,16	2,37	
Average N-gain Value				0,47	Keep

Based on table 9, it is shown that the results obtained from the thermomorphized N-gain test differ from each critical thinking indicator. The aspect of providing simple explanations (MPS) received a score of 0.80 in the high category, the aspect of building basic skills (MKD) received a score of 0.29 in the low category, the concluding aspect (MYN) received a score of 0.59 in the medium category, the aspect of providing further explanations (MPL) received a score of 0.31 in the medium category, and the aspect of developing strategies and tactics (MST) received a score of 0.38 with medium category. The average N-gain value for the five indicators/aspects of critical thinking was 0.47 in the medium category.

Disseminate

At the dissemination stage, it is carried out by socializing the teaching module through the distribution of questionnaires to teachers and students. This distribution is intended to obtain responses, feedback on the teaching modules that have been developed. If the response of the target users of the module is good, then printing in large quantities and marketing will be carried out so that the teaching materials are used by a wider audience. The data from the teacher's response obtained from the distribution of the questionnaire are:

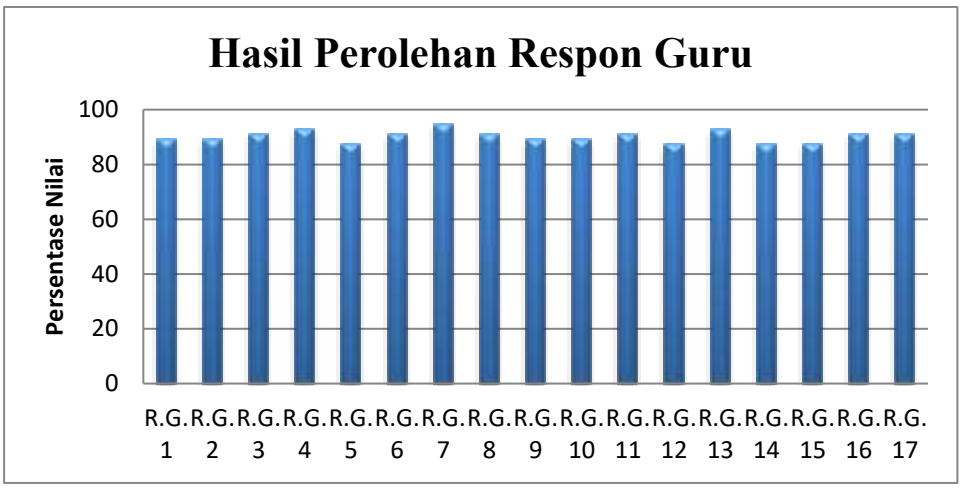
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Figure 2 Diagram of Teacher Response Results
About the Baerbasis Geography Teaching Module *Problem Based Learning*



Based on Figure 2 above, the teacher's response to the developed teaching module showed positive results, there were 17 teachers as respondents who responded very well to the teaching module. From the percentage criterion with the highest score was 95% from 1 person, while the lowest score was 88%, with the number of students who responded as many as 4 people (Afdan, 2025). The analysis is based on 4 aspects, namely 1) the suitability of the module with the independent curriculum, 2) the quality of the material through the teaching module, 3) the impact on learning motivation, and 4) general impressions and suggestions for the geography teaching module. The score from the teacher's response results can be seen in the following diagram:

DISCUSSION

Based on the results of the research and development described, a Geography teaching module based on *Problem Based Learning* (PBL) was produced to improve critical thinking skills in class XI biodiversity materials that have been obtained by researchers. The formulation of the problem in this study will be answered in the following discussion:

The Validity of the Problem-Based Learning *(PBL) Based Geography Teaching Module* to Improve Critical Thinking Skills in Biodiversity Class XI

The level of validity of teaching module products is obtained based on test results data conducted by several geographer lecturers. The aspects assessed by the validators/experts of

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the teaching module include 10 aspects with a total of 20 indicators. The test results showed that the modules developed were very valid in all aspects, with scores from teaching module 1 experts of 90% and teaching module 2 experts of 87.5%. So that the average percentage of all aspects of assessment by teaching module experts reached 89.38%, which was included in the criteria of being very feasible. Based on these results, it can be concluded that the biodiversity material prepared in the Geography teaching module is based on *Problem Pased Learning* to improve critical thinking skills is stated to be very valid and feasible to be used as a teaching module in learning (Ahmad Fadli et al., 2024).

This explanation is in line with the research previously conducted by Muammar Gaddafi, 2024 who developed an independent curriculum-based teaching module on measurement materials and obtained validation results from module experts with a very valid category, which is 93.75%.

The Practicality of Problem-Based Learning *(PBL) Based Geography Teaching Modules* to Improve Critical Thinking Skills in Biodiversity Grade XI

a. Student Responses and Teachers' Responses to Geography Teaching Modules

The practicality of the Geography teaching module developed using the *Problem Based Learning (PBL)* approach was evaluated through responses from students and teachers to the implementation of modules in the classroom. This teaching module is designed to facilitate active learning, encourage problem-solving, and foster students' critical thinking skills, especially in understanding biodiversity material.

The practicality of using the teaching module was carried out through a questionnaire in the form of student responses with a trial limited to 25 students in class XI consisting of 11 men and 14 women. The aspects of the student response questionnaire that were tested included 4 aspects with a total of 12 indicators. Students' responses reflect the practicality of the module from the direct user side. Based on the results of the questionnaire, students gave Positive response which is shown by the average score obtained of 87% of the excellent category. Student responses reflect the practicality of the teaching module from the direct user side. As for the teacher's response to the teaching module, where this module has been very good in terms of conformity with the Independent Curriculum both in terms of learning independence, learning approaches, and student competency development. Then the material and implementation, this teaching module is very good and practical to use. With the score obtained by the average score of 90% of the category is excellent (Azkia & Maksum, 2024).

This is in line with previous research conducted by Dwi Nugroho Gilang, 2022. The results

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of the module practicality questionnaire developed with a total of 5 indicators in the small group trial were 86.5% with the very good category. So it can be concluded that the Geography teaching module based on *Problem Pased Learning* to improve critical thinking skills of biodiversity material is stated to be very practical and suitable for use as a teaching module in learning.

b. Observation of Student Activities Using Geography Teaching Module

The next stage examines the practicality of using the geography-based Problem Based Learning (PBL) module through a trial in the learning process. PBL provides students with opportunities to explore and develop curiosity through problem orientation, information gathering, analysis and synthesis, communication and collaboration, as well as evaluation and reflection (Nursyifa et al., 2024).

The PBL-based geography module was implemented over three meetings. Its activities are designed to strengthen students' critical thinking and actively involve them in repeated learning experiences, helping knowledge last longer. By applying PBL, students not only learn theory but also face real-life challenges relevant to their daily environment, aligning with the principles of PBL as a model that uses real problems to build critical thinking, problem-solving skills, and knowledge (Aris Shoimin, 2019).

Referring to Figure 4.10, observations from two observers across the three meetings show average scores of 75.5% for problem identification, 73.5% for information gathering, 73.5% for analysis and synthesis, 73% for communication and collaboration, and 74% for evaluation and reflection all categorized as good. Overall, students were active in learning with the PBL geography module, indicating that the module meets practicality requirements.

1) Discussion of the Effectiveness of Problem-Based Learning (PBL)-Based Geography Teaching Module to Improve Critical Thinking Skills in Biodiversity Grade XI

In the final stage of this study, the effectiveness of the teaching module in improving Grade XI students' critical thinking skills was measured using pre- and post-tests with a minimum mastery criterion (KKM) of 70. The written test contained eight questions covering indicators of simple explanation, basic skills, drawing conclusions, further explanation, and developing strategies and tactics, scored using standard test procedures (Panjaitan, 2019).

Figure 4.14 shows that the greatest improvement occurred in the simple explanation indicator, reflecting students' ability to express ideas clearly based on everyday contexts. This indicator reached a high category (N-gain 0.80) (Sujiono & Widiyatmoko, 2019). The conclusion indicator also showed a notable increase, demonstrating students' improved ability to draw conclusions related to biodiversity issues, with a medium category (N-gain 0.59). The strategy

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and tactics indicator rose as well, as students applied relevant concepts to solve problems, also in the medium category (N-gain 0.38) (Amaliyah et al., 2023).

Overall, the critical thinking skills of 25 Grade XI students improved, with an average N-gain of 0.47 (medium category), indicating that the Problem-Based Learning Geography module is effective in enhancing students' critical thinking.

CONCLUSION

Based on the results and discussion, the PBL-based geography teaching module designed to improve critical thinking skills is suitable for use in terms of validity, practicality, and effectiveness. The findings show:

1) Validity

The module meets the validity criteria, with Validator 1 giving a score of 3.5 (87%, very feasible) and Validator 2 giving a score of 3.6 (90%, very feasible).

2) Practicality

The module is considered practical based on student and teacher responses, which reached 90.92% and 90.23% (very good). Student activity observations also show good results: 75.5% for problem identification, 73.5% for information gathering, 73.5% for analysis and synthesis, 73% for communication and collaboration, and 74% for evaluation and reflection.

3) Effectiveness

The module is effective in improving students' critical thinking skills, shown by an N-gain score of 0.47 (medium). Indicators include simple explanation (0.80, high), drawing conclusions (0.59, medium), and developing strategies and tactics (0.38, medium).

The module developed in this study covers only biodiversity; therefore, future development should include broader material. Teachers are encouraged to continue developing modules and learning media using various platforms to improve student learning outcomes, especially in environment-related topics..

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